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Forestry Research West

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A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture.

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In This Issue

Cover

Scientists with the Intermountain Station's STEM program have investigated new methods of utilizing small-stem and other marginal stands of trees. One method, shown here, is called whole-tree harvesting, which processes the whole tree into multiple products near the harvest site. Details begin on page 6.

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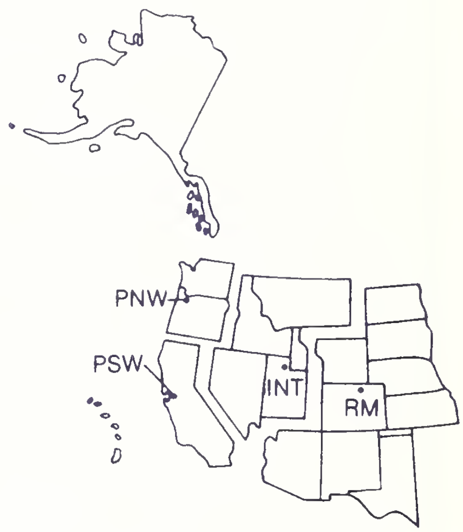
Western Forest Experiment Stations

Pacific Northwest Research Station (PNW)
P.O. Box 3890
Portland, Oregon 97208

Pacific Southwest Research Station (PSW)
P.O. Box 245
Berkeley, California 94701

Intermountain Research Station (INT)
324 25th Street
Ogden, Utah 84401

Rocky Mountain Forest and Range Experiment Station (RM)
240 West Prospect Street
Fort Collins, Colorado 80526-2098



Tying wood quality to growth and yield

by Dorothy Bergstrom
Pacific Northwest Station

People who commit land to timber production need to know what they can expect from plantations—seedlings planted for future crops—compared with trees that grow naturally. How fast will plantation trees grow? How will they differ in size and form from naturally grown trees? What will the wood they produce be like? Will it be suitable for construction material like trusses, laminated beams, and plywood? Or will it be suited only for paper, particle board, low-grade lumber, and fuel to produce heat and electricity? Can specific silvicultural methods be counted on to produce wood that, decades later when trees are cut, has the characteristics needed for the products likely to be in demand at that time?

Organization formed

To answer these and related questions, particularly about the development of plantations with early spacing control, 22 organizations in the United States and Canada formed a new organization in January 1985. Called the Stand Management Cooperative, it is made up of 6 public agencies, 5 universities, and 11 timber companies. Its purpose is to conduct an integrated program of research to define the effects of silvicultural treatments on the growth, yield, and wood characteristics of trees grown under various regimes of intensive management in coastal British Columbia and western Washington and Oregon.

Why the organization was needed

The idea for the cooperative evolved as people in the forest-land-managing public agencies and the timber industry recognized a common need for information about the future growth, yield, and wood quality of young managed stands that would represent a wide range of silvicultural regimes and growing conditions. A cooperative arrangement would also offer a way to finance the considerable expense of acquiring an adequate volume of statistically sound data.

The need for better information was first recognized by mensurationists who were responsible for preparing yield tables and computer simulation programs for predicticting stand development. One of the first to voice his concern was Bob Curtis, a mensurationist at the Pacific Northwest Station's Forestry Sciences Laboratory at Olympia, Washington.

Using an increment borer to remove cores from a sample tree for analysis at Oregon State University.

What was needed, he said, was a cooperative arrangement to gather data that would provide results applicable to most timber-growing operations and would continue to do so over several decades.

Most knowledge about the growth of trees has come from natural stands. Although stands with little or no silvicultural attention are gradually being replaced by plantations that have early density control and a variety of other treatments, little is known about the development of these stands.

One example of the lack of knowledge concerns wide spacing—a practice that has gained favor in recent years. Wide initial spacing reduces planting costs, produces merchantable trees quickly, and delays the need for thinning, yet little information is available about its effects on tree size, crown development, wood quality, and other characteristics. Current stand simulators cannot provide reliable estimates of the development of plantations or stands that were thinned to relatively wide spacing at an early age because there are so few data. And there is little information on how such stands respond to additional silvicultural treatments.

Commercial thinning is another practice with unknown results. Available information comes from natural stands that were thinned relatively late and had had no earlier stocking control. By the time they were thinned, their ability to respond to the additional growing space may have been reduced.

Another important unanswered question is what will the wood be like? This question was raised several years ago by another Pacific Northwest Station researcher, Tom Snellgrove, Project Leader for wood quality research. He is one of those who has questioned the assumption that tree size alone determines value. He points out that the value of trees cut and removed from the forest depends entirely on the value of products made from the wood. "We know that in naturally grown trees diameter is closely related to value," he says, "but other tree characteristics will be more important in intensively managed stands."

Snellgrove explains that trees planted at wide spacing and otherwise intensively managed may have quite different characteristics and wood properties along with greater volume. They are likely to have a higher proportion of juvenile wood, with wide growth rings, and large, persistent branches. "This means," he says, "that they probably will produce a higher proportion of wood of low specific gravity, that is also low in stiffness and strength, and may shrink and warp more than wood from naturally grown trees. The wood may also have poor machining and gluing characteristics and poor appearance." In other words, practices that produce the biggest trees or the most volume in the least time are not best if the wood produced is suited only to low-value uses.

Although quality of wood has been a major factor in the ability of the timber industry in the Pacific Northwest to compete in national and international markets, little is known about the effects of silvicultural regimes on wood properties. Some people believe these effects may turn out to be more important than producing more volume of wood.

The conviction of Curtis and Snellgrove that better data were needed for planning the management of timber plantations was shared by others who played important roles in the meetings, discussions, and planning that eventually led to formation of the cooperative. Some of the key people in this effort were Frank Hegyi, British Columbia Ministry of Forests; Dave Hyink, Weyerhaeuser Company; Kim Iles, MacMillan Bloedel; and Bill Atkinson, Crown Zellerbach (now at Oregon State University).

All agreed that public agencies and timber firms needed better data for decisions about initial stocking, thinning, intensity and frequency of fertilization, pruning, determining allowable cut, and scheduling harvests. They also agreed that a cooperative arrangement to collect and pool data from different ownerships, using standardized experimental designs and procedures, would provide more extensive and compatible information. A cooperative organization would offer two additional advantages: data from many locations would form a more reliable basis for planning and forecasting, and sharing costs

A technician uses calipers to measure branch diameters at an installation on Weyerhaeuser Company land near Enumclaw, Washington.

would provide a greater return on each cooperator's investment. A strong need was also identified for a sharper focus on wood quality research and better communication and coordination of effort among researchers.

Headquarters established

To provide coordination, continuity, and quality control, the organization established headquarters in Seattle at the University of Washington College of Forest Resources. Nick Chappell was selected as executive director. Chappell is also director of the Regional Nutrition Research Project at the university, and the two organizations share centralized fieldwork and data management. The cooperative is organized to include direct participation in fieldwork and research by cooperating members rather than only by the host institution.

Work is divided into a Silviculture Project, led by Douglas Maguire, also of the College of Forest Resources, and a Wood Quality Project, led by Snellgrove. Technical direction for the two projects is given by separate technical advisory committees, and administrative advice is provided by a policy committee.

Work begun

Work scheduled for 1986 and 1987 has gone according to plan. A data management system has been established. Five-year plans have been developed for both the Silviculture Project and the Wood Quality Project.

Silviculture project

A survey of existing data has been made and the framework for a data base system developed. A manual of specifications and procedures has been prepared to guide all operations.

Selection and installation of field plots has begun. About 60 field installations in both Douglas-fir and western hemlock are planned over a 5-year period (1986-90). These will be of three general types: (1) a basic installation with a wide range of treatments, intended for long-term use; (2) an installation with a more restricted set of treatments, intended for interim use; and (3) new plantations with a wide range of spacings, to provide for future experimental areas.

Although the initial emphasis of the silvicultural work is on plot establishment and data collection to assess effects of initial spacing and early stocking control and their interactions with other factors, this work and future work are expected to lead to improved stand simulators, yield estimates, and stand treatment guidelines.

The interactions of spacing regimes with other silvicultural practices such as fertilization, vegetation control, and the selection of planting stock for genetically determined traits will also be studied.

Wood quality

A review of available information on silvicultural practices and Douglas-fir wood and product quality has been completed.

Three aspects of wood quality have been selected for study and will be addressed concurrently in a series of coordinated studies. One study will examine the effects of management on product yield and wood quality in stands with known histories of treatment. The second will look at the effects of management practices on basic tree characteristics and wood properties, such as specific gravity, ring width, and knot size and distribution. The third study is about the relation of selected basic wood properties to mechanical properties. Future work will be increasingly linked with the Silviculture Project field installations.

Differences in branch development are related to stocking level.

A real strength of the cooperative is the opportunity to draw on the talents and experience of researchers from different institutions and companies. In the first wood quality study Tom Fahey, a research forester at the Pacific Northwest Station, is responsible for designing and conducting a regional study relating tree characteristics to the quality of lumber and veneer. This study has spawned a number of collaborative studies all coordinated through the cooperative. Wood Technologist Bob Megraw of Weyerhaeuser Company used Fahey's sample to develop wood density profiles of tree stems.

Dave Briggs, a forest products technologist at the University of Washington and Roy Pellerin of Washington State University are evaluating mechanical properties of lumber from the same sample. And Oregon State University Wood Technologist Bob Krahmer is using X-ray densitometry to analyze specific gravity ring by ring. Additional research on wood permeability and optical scanning of veneer is being conducted by Oregon State University, and on veneer strength by Trus-Joist Corporation.

Standards and guidelines

To provide the standardization needed to produce data that are consistent and can be pooled for analysis, the cooperative prepared a manual of specifications and procedures. The intent was to avoid some of the defects that Curtis had found to limit or destroy the usefulness of much existing data for preparing yield tables. The defects include poor documentation; inadequate or inaccurate measurements; plots that are excessively small or lack buffers; data codes and measurement standards that are inconsistent or incompatible; and records that are poorly organized, incomplete, or contradictory.

Conclusion

Scientists have spent a great deal of time and effort learning how to get trees to grow bigger faster. Much has been learned about selecting seed likely to produce fast-growing trees and suited to the planting site, about the effects of environmental factors on growth and yield, about the responses of trees to fertilizers, and the importance of preserving diversity. Now, with establishment of the Stand Management Cooperative, a start has been made toward closing the gap between knowledge about silvicultural management and the resulting wood and the quality of products it will make.

In addition to closing the current gap in knowledge, the cooperative is looking to the decades ahead. By establishing research areas for future studies, the researchers are providing opportunities for colleagues of the future to search for answers to questions that may be asked by a society whose perspectives and priorities may differ from those that predominate in 1988.

Additional information about the cooperative is available from:

H. N. Chappell, Executive Director of the Cooperative, College of Forest Resources, University of Washington, Seattle, WA 98195; telephone (206) 543-9527.

Douglas Maguire, Silviculture Project Leader, College of Forest Resources, University of Washington, Seattle, WA 98195; telephone (206) 543-2395.

Tom Snellgrove, Wood Quality Project Leader, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR; telephone (503) 231-2106, FTS 429-2106.

Grading lumber in a product recovery study near Eatonville, Washington.

A STEM supporting small timber utilization

by Elizabeth Close
Intermountain Station

Physical and biological consequences of alternative harvesting methods, including such diverse concerns as fuel buildup, esthetic quality, and understory vegetation response, were investigated by STEM researchers.

It is one of the loveliest landscapes in the country. The steeply-rising forested slopes of the Inland West, following the Rocky Mountain chain from Canada south to the timbered portions of Arizona and New Mexico. Slender trees spiral upward. The species found in these sometimes richly mixed but often solid stands include lodgepole pine, ponderosa pine, Douglas-fir, Engelmann spruce, western larch, several true firs, and aspen. In the past these forests have often remained undisturbed, escaping society's constant search for wood and wood fiber-based products. The forests themselves have often served as the major deterrent to the utilization of their timber.

Often to resource managers, who were charged with caring for this land and managing its resources, the steep forests of small trees were a pain in the neck. Their frustration focused not only on the underutilized wood source, but on the need for harvesting to accomplish multiple-resource objectives. The concerns grew into a priority research need, a problem area in which wise and knowledgeable National Forest management was hampered by a lack of information.

In 1979, the Intermountain Research Station (INT) responded to the need by initiating a Research and Development (R&D) Program named STEM, Systems of Timber Utilization for Environmental Management, to address barriers to utilization of small-stem and other marginal stands of trees. Ron Barger, who was then Program Manager for the Station's Forest Residues R&D program at the Forestry Sciences Laboratory in Missoula, Montana, was appointed STEM's Program Manager. STEM's initial charter defined a 5-year program that was later extended through 1986. Now STEM has ended, but a foundation remains for research and application for many years to come.

The untouchable forest

The timber resource in the Inland West frequently exists under conditions that would scare away any logger trying to make a buck. These conditions include:

—The size of the trees. A significant portion of this region supports stands of trees that are smaller than traditional sawtimber size, with stems roughly less than 9 inches diameter-at-breast-height (d.b.h.). Such trees are referred to as small-stem timber, or as poletimber, if the stem's d.b.h. is between 5 and 9 inches. Poletimber stands alone cover about 16 million acres, more than one-fifth of all commercial timber land in the Inland West. Some sites are covered by second-growth stands,

but the most extensive condition involves stands of species that are characteristically small at maturity, and may be overstocked and stagnated. The two major species almost universally considered small timber on this basis are lodgepole pine and quaking aspen.

—Extensive insect and disease damage. Tree mortality due to insect and disease activity—especially mountain pine beetle—has reached epidemic proportions in a number of areas in the Interior West. Although much of the dead timber may stand for years, its suitability for high-value products declines rather rapidly as stems weather and split. Reduced product values further reduce the margin available to cover the cost of harvesting the trees.

—Steep terrain and limited access. Much of the underutilized timber resource is located on steep, irregular terrain, often complicated by the presence of highly erosive soils. Both environmental and economic concerns limit road access and dictate road location and design standards.

—Low timber volumes per acre. In small-stem stands, as well as in stands of larger timber, volume per acre available for removal is often relatively low. Harvesting these trees requires equipment that is mobile, easily set up or rigged, and capable of extended reach or travel to operate economically in such stands.

Innovative cable systems, like this trailer-mounted skyline, can significantly improve the opportunities for recovering small-stem material on steep terrain.

In addition to these constraints, a number of environmental and resource management concerns limited ways that timber could be harvested. Timber harvesting and accompanying road construction have a high potential for substantial environmental damage, including soil loss, sedimentation and water pollution, visual degradation, and damage to the productive capacity of the site.

So if that's the case, why bother? Why not leave the steep-sloped, small-stemmed forests of this region free from harvest? According to managers, the answer is often for the good of, and even the future existence of, these very forests. Timber harvesting is a management tool useful, and in many circumstances necessary, in achieving nontimber resource management objectives. In the Rocky Mountain area especially, timber is rarely harvested from public lands just to obtain wood fiber. It is more likely that tree harvesting be done for insect and disease control, improved wildlife habitat, watershed management, or enhanced recreation potential.

Another reason to bother is of course for the wood fiber itself. Our country's demand for wood and wood fiber-based products is growing, and is expected to increase at an even more rapid rate. Environmental considerations also favor extending the use of wood, a renewable resource that can be processed with less energy and less pollution than most alternative materials. Recent interest in the use of biomass fuels to supplement or replace scarce fossil fuels further increases potential demand for the wood resource.

And, as demand grows, the land base available for timber production is being reduced by allocation of lands to other uses, underscoring the need to improve utilization of currently unused wood resources. Relatively little had been done to improve utilization opportunities for predominantly small-stem, and apparently submerchantable timber.

Little had been done, that is, until the STEM Program.

Under the research umbrella

The STEM Program was designed like a research umbrella, spreading open as a special emphasis over INT's existing research projects. STEM was never funded or staffed as a separate research program. Instead it was up to Program Manager Barger to call on existing research projects and cooperators to accomplish STEM-related work. Participating scientists' involvement usually had a dual objective—to accomplish their own research project assignments, and to contribute to the growing field of knowledge surrounding the STEM initiative.

While several INT scientific units participated in STEM at least as technical consultants, the redefined research priorities of three core research work units fit neatly under the STEM umbrella. These projects included:

—<u>Forest Engineering Research</u> - Located at the Forestry Sciences Laboratory in Bozeman, Montana, this unit was embarking on a program of research that included intensive evaluation of the environmental impacts and cost-effectiveness of alternative forest road design and construction practices. The scientists were also working to develop guidelines for access and resource management on unstable sites.

—<u>Utilization Research</u> - This unit at the Forestry Sciences Laboratory in Missoula, was directed toward extending harvesting and utilization technology to underutilized timber resources, including small timber and other submerchantable material. It's mission included evaluating the role of timber harvesting and utilization as a multi-resource land management tool.

—<u>Forest Economics Research</u> - At the Forestry Sciences Laboratory in Missoula, this unit was addressing problems of identifying specific multiple-resource management costs on public lands, especially in situations where timber harvesting was used to meet multiple-resource management objectives. Another part of the work centered on devising methods of allocating costs among benefitting resources, and developing methods of evaluating the cost-effectiveness of alternative management activities.

The work carried out by these three units provided much of the primary research basis for the STEM Program, and constituted the central core of expertise, experience, and on-going research from which the program developed. The STEM Program functioned as an integrating and implementing unit, combining the efforts of these projects with those of other cooperating projects, all to address small-stem timber harvest and utilization.

"Because STEM work was conducted within ongoing research initiatives, there is a certain amount of confusion about what is in or out of the STEM program," Barger says. "If you view the mission on the broadest basis, work in the core research work units contributed 100 percent to STEM."

Products recoverable from small-stem stands include posts, rails, props, and other similar roundwood products, as well as potential fiber and fuel products.

"Take for example the research in the Forest Economics project on below-cost timber sales" (see Forestry Research West, November 1986). "Erv Schuster's excellent and widely publicized work is seldom thought of as directly linked to STEM, but the below-cost sale issue is at the heart of the problem with small stem harvesting."

The STEM umbrella stretched even further. In addition to the efforts of INT research work units, STEM relied heavily on cooperative research and participation by land managers, university researchers, industry collaborators, and consulting foresters and researchers. One major cooperator, the Bureau of Business and Economic Research at the University of Montana, "carved off pieces of the total problem that they could handle," according to Barger. STEM backing assisted Charles E. Keegan III to complete a number of now widely-referenced works, including *Value of Wood to Competing Users: Energy vs. Product Uses in the Inland Empire*, and *The Cost and Availability of Forest Residues in the Northern Rocky Mountains*.

From a problem tree . . .

The STEM program started out with no species emphasis—all those Inland West species considered marginal, small-stem timber were included. But during an extensive problem analysis phase, Forest Service managers in the Northern and Intermountain Regions emphasized that their number one priority problem was clearly management of small, overstocked lodgepole pine stands. This gave STEM a needed species focus. While subsequent program findings could just as well apply to aspen, Douglas-fir, or other species, lodgepole pine became the tree of choice for a significant number of STEM studies.

. . . To a cinderella species

The mountain variety of lodgepole pine (*pinus contorta* var. *latifolia*) is one of the most widely distributed pines in western North America, extending from southern Colorado north to the central Yukon, and from 1,500 to 11,500 feet in elevation. Lodgepole pine forests occupy about 12.4 million acres within the United States portion of this broad geographical area. About 7.6 million acres of this resource are classified as small-diameter or poletimber lodgepole.

One popular impression of lodgepole pine was that of a skinny tree growing out on the edge of nowhere. This impression also hints at the primary source of the economic problems limiting large-scale utlization. But now lodgepole pine is often termed the "Cinderella species" because of its relatively recent emergence as a desired lumber source. Before the mid-1940's, lodgepole pine was utilized primarily for railroad ties, mine timbers, corral and barn poles, and house logs. Following the 1940's, the pattern of utilization changed as a result of increasing demands for softwood

construction products, and development of more efficient small-log milling systems. Demand has increased steadily since then, as it became known that the physical properties of lodgepole pine wood also favor utilization for sawn products. The wood dries well, is light in weight, and contains small, tight knots, making it competitive with other sawn product species.

STEM's chief wood scientist

STEM's work with the species really took off when, in 1983, Peter Koch came to the program in Missoula as Chief Wood Scientist to work on utilization of lodgepole pine. Koch transferred from the Southern Experiment Station of the Forest Service, and was well-known for his expertise, including authorship of a two-volume USDA Agricultural Handbook entitled, *Utilization of the Southern Pines.*

"Before Koch arrived, the program had been weak in the wood technology area," said Barger. "But his work soon became almost 50 percent of what STEM was about. He shifted the emphasis to a more indepth study of the extensive lodgepole stands across the entire North American range. An initial product of this work is Intermountain Research Station General Technical Report 227, *Gross Characteristics of Lodgepole Pine Trees in North America*, issued this year. Other research reports on this work will follow."

Both clearcutting

. . .and intermediate harvest cutting or thinning are viable management options for pole-size lodgepole pine, depending on specific management objectives and the stand character.

In *Gross Characteristics*, Koch presents North American lodgepole as an industrial raw material, based on analysis of complete-tree specimens collected from the full range of both variety *latifolia* in the United States and Canada, and variety *murrayana* collected from Oregon and California. His detailed study compares and correlates the trees' location with their growth form, general characteristics, and even indepth analysis of moisture content of heartwood, sapwood, foliage, and wood and bark of roots, stems, and branches.

The lodgepole pine resource characterization lays in the foundation for further work. Laboratory studies are underway evaluating detailed physical, chemical, and mechanical properties of lodgepole pine wood. These results lead into a series of related studies that are investigating new product/process options and industrial utilization opportunities for lodgepole pine, especially for sub-sawtimber size trees.

The cost of the cut

But low-cost harvesting of small-stem lodgepole pine is central to successful utilization of the species. And forest managers still needed to know how to simplify the process for making appropriate silvicultural decisions in small-stem lodgepole pine forests. The wide range of geographic, ecologic and physiographic conditions in which the species grows comprise its "site", and provide the first clues to what must be considered in any silvicultural treatment. And the site factors in lodgepole pine management often included steep slopes, unstable soils, and insect-damaged, stagnated stands.

"Because of these generally poor stand conditions and marginal economic opportunities, it was pretty well thought that you must clearcut in lodgepole," said Barger, "But there are often good reasons not to. Considerations for wildlife, recreation, watershed, and other uses often make partial or intermediate harvesting methods, where a share of the trees are left standing, a better choice."

"Because lodgepole had only emerged recently as a bona fide timber tree, there was little information about alternative harvesting methods. We found little reported data in the literature that described the impacts of partial cutting or intermediate harvesting. There was nothing about how lodgepole pine stands would respond, or about the economic feasibility or environmental or biological impacts of partial cutting treatments.

"Managers in the Northern and Intermountain Regions of the Forest Service expressed a particular interest in management options other than simply clearing by clearcutting, slashing, trampling, or burning. Partial or intermediate harvest cutting offers desirable biological advantages, but raises obvious questions of economic feasibility, residual stand response, stand damage, and management constraints. The research undertaken was in part an effort to shed light on these kinds of questions and concerns.

"The managers needed some alternatives, and STEM set out to find them," Barger said.

Because intermediate harvesting alternatives get into the area of silvicultural prescriptions, involvement of silvicultural researchers in both planning and evaluating such alternatives was essential. It was at that point that another INT unit moved closer under the STEM umbrella.

The contributor, INT's Subalpine Forest Silviculture unit in Bozeman, quickly became a principal collaborator. "This unit should have been with STEM since day one." says Barger. "It just turned out to be one of those instances where our program needs and their research objectives meshed."

Sites for lodgepole pine study

With the aid of National Forest and Ranger District personnel, 25 field study sites in Montana, Utah and Wyoming were selected. These sites represented as wide an array as possible of stand age, tree size, and density, within natural stands where trees were three to seven inches in average diameter at breast height. Other site selection criteria included access by an existing road, that the terrain be operable with wheeled or tracked harvesting equipment, and that the stand be considered precommercial for sawtimber.

Each study stand was laid out to include both a light and a heavy level of intermediate harvest, plus an untreated control area. A sample of residual untreated trees were permanently identified to provide a basis for evaluating response to treatment. "The actual harvesting, according to the specifications laid out, was done by local loggers on service contracts," Barger says. "This worked out well in most cases, but some of these logging operations are really running on a shoestring. The trees are still standing on a few sites because of defaulted contracts."

The study sites were used to carry out a number of STEM objectives in three broad research areas: analysis of silvicultural practices, harvesting and utlization practices, and management consequences of the harvesting activity, or stand treatment. Results included costs and feasibility of alternative harvesting treatments, damage to residual stands from natural causes, and information on how the harvest treatments influenced other resources. The sites will continue to be monitored and sample trees remeasured periodically, to fully evaluate stand and site response to the harvesting activity.

A clipper is sometimes used to recover fuel from harvesting residues.

This research generated needed information on predicting product potential from existing stands. A significant research effort went into development and verification of a product prediction model for roundwood products in lodgepole pine 3 to 7 inches in diameter. The model provides a consistent and unbiased approach to appraising product options and values in stands being considered for harvest. The combination of harvesting costs and predicted recoverable product values provides the best approach to identifying those stands that offer the most attractive economic opportunity.

Using harvesting treatments to achieve a combination of timber-oriented and nontimber management objectives raises economic questions of costs incurred and benefits achieved, now and in the future. For treatments applied to small-stem lodgepole pine stands, STEM research identified both the nontimber and timber resource management objectives of concern and defined costs and benefits associated with them.

And that is just what the Forest Service managers in the Intermountain and Northern Regions wanted. It should have been, because STEM researchers worked at every step to include the managers in their projects.

"We were pretty successful at getting National Forest involvement, because every study site was on a National Forest. Employees were aware of what was going on—we had lots of visitors. Conducting a joint effort on a common study site is a very effective way of both getting advice, and transferring research results. And twice we organized more formal tours of the research sites for Forest Service timber resources managers."

STEMing out from the end of the program

Another activity that got STEM results out to those who needed them was a workshop on Management of Small-Stem Stands of Lodgepole Pine, held June 30 through July 2, 1986, at Fairmont Hot Springs, Montana. Over 100 resource managers and researchers attended the workshop, which represented a form of closure for the STEM project. The presentations included what had been accomplished in this Research and Development initiative, and also included outlines of the work that will continue beyond the special program emphasis. The workshop proceedings have been issued as *Management of Small-Stem Stands of Lodgepole Pine—Workshop Proceedings*, Intermountain Research Station General Technical Report 237.

The STEM program has ended. But a stem is only part of a plant. It usually supports something else—branches, flowers, leaves—that are more characteristic parts of the whole plant. For this reason STEM was an apt choice of names for this particular project—the biggest contribution may be its solid support of research and development yet to be done. The many technical publications from STEM form the sound foundation of knowledge that will be the basis for future utilization work.

"Five or seven years is just too short," Barger said. "We don't get the chance to benefit fully from what we learned. That's a problem with every R&D program trying to come to an orderly conclusion. You may have arrived at the end, but the program is not yet completed. If we could just do one iteration of our field studies, we would unquestionably come much closer to defining the most promising harvesting systems and techniques."

Barger has retired from the Forest Service, and is an assistant professor at the School of Forestry, University of Montana. Peter Koch is retired as well, but is working from his own Wood Science Laboratory, south of Missoula in the Bitterroot Valley. From there, Koch continues to study the species and work with utilization of lodgepole pine.

STEM provided some, but not all, of the final answers on management issues in small lodgepole pine. And the models, analyses, and projections developed and discussed provide managers with a better understanding of the management implications of any stand treatment, and an improved knowledge of factors critical to stand and site response.

An unpretentious rodent?

by Amy Halvorson, for Rocky Mountain Station

Prairie—a place where 16th and 17th century Spanish explorers sought gold, and instead found seas of coarse, hardy grasslands, void of trees and gold-bearing streams. Indians saw it as a land of milk and honey, designed by the "Great Spirit" to provide all their earthly needs. Unknown to them at the time, the small unpretentious burrowing rodents that shared their prairie homeland and were a source of food, would someday become a bane to farmers and ranchers, and a focus of scientific research.

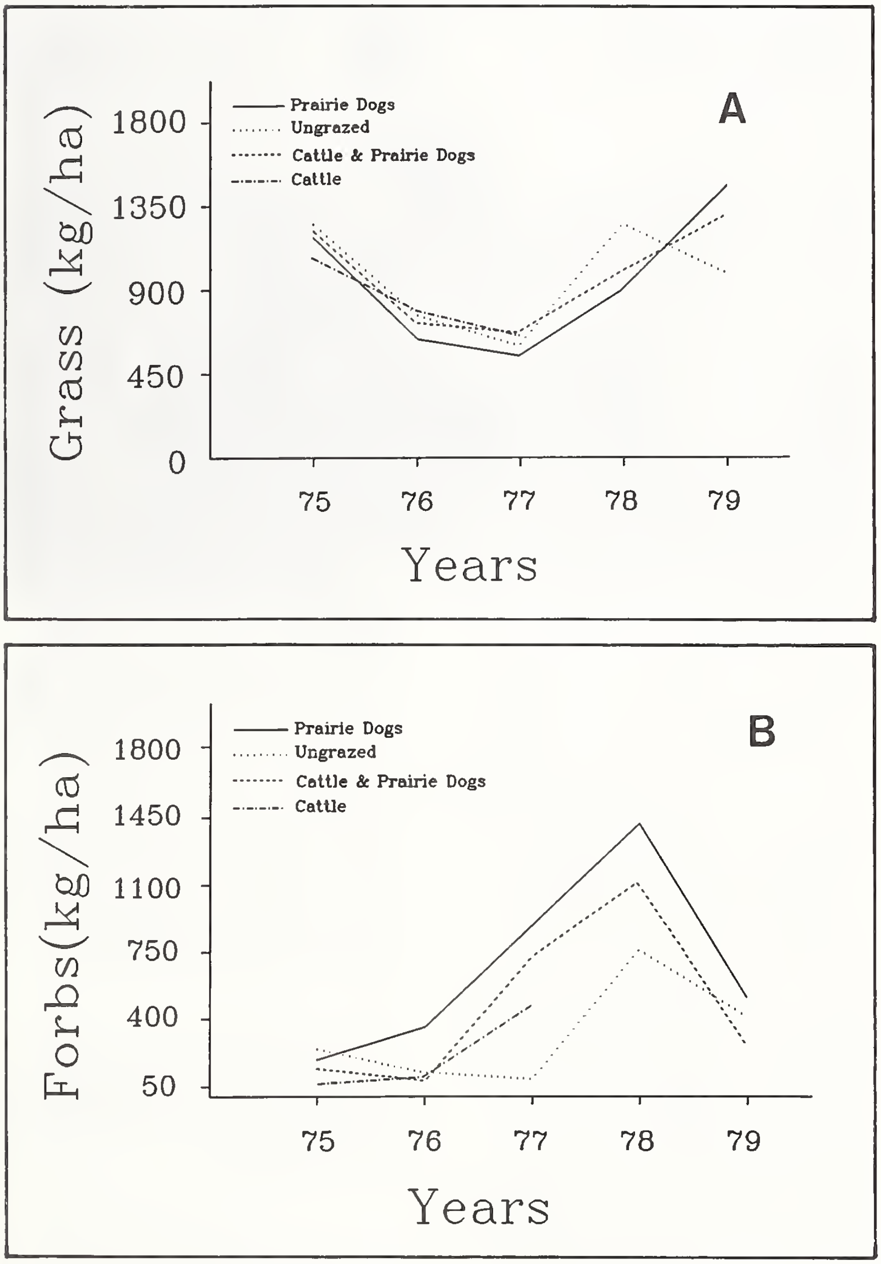
Since the late 1800's black-tailed prairie dogs, *Cynomys ludovicianus*, have been considered pests on rangelands of central North America. Studies around the turn of the century showed that 256 prairie dogs, a moderate-sized colony, could eat as much forage as one cow! Moreover, farmers were finding that the animals sometimes ate their crops. The prairie dog was eating its way out of friends and into trouble. Reduction of their numbers appeared inevitable.

Today, concerns over prairie dogs still exist. In fact, large-scale control programs are being conducted by farmers, ranchers, and government agencies—programs that are expensive (costs as high as $6 per acre on land which generates annual grazing fees of only $2.95 per acre) and not always effective. Through it all, the prairie dog perserveres.

*The black-tailed prairie dog (*Cynomys ludovicianus*).*

You can hear a wide variety of agreements and disagreements about the effectiveness and need for prairie dog control, but several questions stand out: what are the effects of prairie dog control on nontarget animals; how do prairie dog colonies affect surrounding wildlife populations; how do different rodenticides compare; and what are the important relationships between cattle and prairie dogs?

Introducing Dan Uresk, research biologist at the Rocky Mountain Station's Forestry Sciences Laboratory in Rapid City, South Dakota. For the past decade he has been studying the black-tailed prairie dog in the northern Great Plains. "The prairie dog is in trouble because it shares a liking for the same vegetation as cattle—primarily buffalo grass, blue grama, needleleaf sedge, and scarlett globemallow. And, not only do they eat grasses intended for cattle, they prefer grasses over forbs, and long-term heavy grazing by the rodents can change plant species composition in some areas," says Uresk. Much of his research was done in the Conata Basin region of South Dakota. This area, a lowland surrounded by bluffs and mesas, is prime prairie dog habitat and supports thousands of colonies.



Peak plant production under four treatments, over a 5-year period. Peak plant production is equal to the sum of the peaks for (a) grasses and (b) forbs.

Plant production

Uresk examined plant production in and around prairie dog colonies in relation to four treatments: 1) no grazing, 2) grazing by prairie dogs only, 3) grazing by cattle only, and 4) grazing by both prairie dogs and cattle. Peak plant production on the "prairie dogs only" treatment was 24 percent more than the "cattle only" treatment, while it was 13 percent more than the "cattle and prairie dogs" treatment. Plant production was similar between the "cattle only" and "no grazing" treatments. "While grasses showed no significant difference in production among treatments, it was a different story with forbs," says Uresk. Forb production was up 165 percent for the "prairie dog only" treatment, followed by "no grazing" - up 91 percent, and "cattle plus prairie dogs" - up 76 percent. The greatest increase in overall plant production occurred with forbs when rangelands were grazed by prairie dogs only.

Uresk also evaluated the effects of prairie dog control on production of 43 plant species. Pre-control treatment included: 1) ungrazed, 2) prairie dogs only, and 3) cattle with prairie dogs. "We came up with some significant findings," said Uresk. "The first was that production of buffalo grass significantly decreased when cattle were allowed to graze the area after prairie dogs were removed. It seems that prairie dog clipping, which leaves very little of the plant above ground, stimulates growth of buffalo grass and even some forbs. On the other side of the coin, increases were found in

western wheatgrass, blue gramma, green needle, and needle and thread grasses AFTER prairie dogs were removed. However, it took about nine years to see any significant increase in these grasses.

Uresk points out an important factor in all this—the economics of improving forage production through prairie dog control. "If we wade through all the dollars and cents data," he said, "we find that it could take up to 40 years for a government agency like the Forest Service or BLM to recover the initial costs of a large-scale irradication program. It could take a private rancher or farmer up to 22 years to recover costs. A much more cost effective alternative is to simply maintain, rather than attempt to reduce, numbers by conducting a full-scale treatment the first year, and then treat no more than 5 percent of your acreage annually. In other words, the bottom line is that prairie dog control is just not economically feasible in most instances except at a very low maintenance level."

Rodenticides

Lab scientists have done extensive studies on two of the most common rodenticides approved for prairie dog control—zinc phosphide and strychnine. The treatments included zinc phosphide-treated grain (prebaited with nonpoison grain) and strychnine-treated grain (both with and without prebaiting).

Rodenticides are mixed with grain and spread by hand or mechanically.

Results show that active burrows were reduced 95 percent using zinc phosphide, 83 percent with strychnine (prebaited), and 45 percent with strychnine without prebaiting. "Evidence shows that the number of active burrows was reduced more by prebaited zinc phosphide treatments than any other method," said Uresk.

Though the evidence is in on the effectiveness of rodenticides, researchers wanted to know the impacts of these chemicals on nontarget animals. In use for prairie dog control since the late 1800's, strychnine appears to be the least selective when it comes to killing. For instance, scientists now know that treated grain can reduce populations of a variety of seed eating birds such as horned larks, mourning doves, blackbirds, vesper sparrows, and western meadowlarks. However, studies have shown no significant mortality for nontarget seed-eating birds with zinc phosphide-treated grains.

Several invertebrates were also studied. For example, spider mites and crickets were not affected by either rodenticide. However, zinc phosphide did produce mortality in ants and darkling beetles. Strychnine had a similar effect on wolf spiders.

Other research shows varying results such as: zinc phosphide reduced deer mouse densities by 79 percent, and strychnine had no effect on rabbits.

Prairie dog - cattle relationships

Black-tailed prairie dog food habits and diets are variable. For the most part, they eat the same forage species as cattle—though they prefer grasses over forbs or shrubs. Yet studies show that where both exist, cattle weights, compared to those in areas without prairie dogs, did not vary significantly. "In 1982," says Uresk, "we began a study to see how prairie dogs faired in areas where cattle were excluded. We were surprised to find that, over a 4-year period, prairie dog colonies did not expand. In fact, some research results suggest that light grazing or periodic exclusion of livestock can actually reduce the population of colonies. It appears that the rodents don't like tall grasses that could help provide cover for predators such as coyotes and foxes. Black-tailed prairie dogs appear to be most abundant in areas that are heavily grazed by livestock," says Uresk.

What benefits?

Despite all the bad publicity that these animals have received, they do benefit some aspects of prairie life. They act as habitat regulators by maintaining shortgrass and "patchy" plant associations with less mulch cover and lower vegetation height than ungrazed or lightly grazed areas. These factors often provide quality habitat for other animal species such as deer mice, grasshopper mice, desert cottontails, rattlesnakes, and a variety of plants. Burrowing owls have been known to utilize abandoned burrows. In addition, greater bird densities and species richness have been observed around prairie dog colonies. "Although this subject needs more study," says Uresk, "it's obvious that prairie dogs influence the abundance and species diversity of birds, small mammals, and vegetation."

Finally, prairie dogs have become an important species for sport hunting in some areas. In South Dakota alone, they provided over 46,000 hunter days of recreation in 1985. This source of State revenue is expected to increase.

The Bureau of Indian Affairs is also doing a study to assess the feasibility of using prairie dog meat as mink food, and their skins for manufacturing gloves.

Like them or not, black-tailed prairie dogs are, and will continue to be, well-known citizens of the Great Plains. If you would like additional information on prairie dog research, write the Rocky Mountain Station for the following reprints: *Relation of Black-tailed Prairie Dogs and Control Programs to Vegetation, Livestock, and Wildlife*; *An Economic Analysis of Black-tailed Prairie Dog Populations Reoccupying Sites Treated with Rodenticides*; *Effects of Controlling Black-tailed Prairie Dogs on Plant Production*; *Effects of Prairie Dogs and Cattle on Vegetation of the Northern High Plains*; and *Effect of Zinc Phosphide Rodenticide on Prairie Dog Colony Expansion as Determined from Aerial Photography*.

Trunk implants protect prime firs

by Richard B. Pearce, for Pacific Southwest Station

Good things do come in small packages, at least that's what USDA Forest Service scientists in California and Oregon have found. Relying on a recent development in the science of pesticide delivery, they discovered in field tests that genetically valuable Douglas-fir specimens could be protected from the ravages of the western spruce budworm by a dozen or so bullet-sized capsules implanted around the base of each tree. So dramatic were the preliminary results that local foresters, who had cooperated with the scientists in the trials, immediately expanded the scientific study to include several thousand Douglas-fir specimens they had selected as parent stock for reforestation efforts.

As a part of the reforestation program, seeds and scions (twigs used for grafting) from "superior" trees are removed to orchards where cross-pollination and vigor can be better controlled. But in Oregon's Umatilla and Wallowa-Whitman National Forests forests, many of the trees exhibiting outstanding growth characteristics are theatened by the hungry larvae of the western spruce budworm, which devour both foliage and young cones.

"It's highly desirable to protect these trees," says Roger E. Sandquist, reforestation entomologist for the Pacific Northwest Region and co-investigator on the implant study. "A big investment has been made in identifying these trees, grafting scions in the seed orchards, and evaluating the progeny."

But the prized trees are often located in remote areas or are difficult to treat by conventional methods. "Characteristically it's a big tree, 60 to 100 feet tall, and it may be 50 miles from town and 100 feet up the side of a mountain," Sandquist noted during a recent interview from his Portland office. "You just don't go out there and spray a single 100-foot tree."

Spraying could be accomplished by air, but Sandquist points out that merely locating the tree can be difficult. And then there's always the tricky problem of hitting the target tree.

Dr Tom Koerber looks on as a forester drills a hole before inserting acephate implant.

For these reasons, Sandquist opted for the trunk implant method, which had already been shown effective against the spruce budworm.

The 1¼ inch long capsules, each containing 875 mg of the EPA-registered insecticide acephate, are inserted every four inches around the base of the tree. The pesticide dissolves in the sap and is transported to the rest of the tree.

"This solves the basic problem of treating the individual tree without having to treat the entire forest," Sandquist said.

Sandquist expected that the trunk implants would afford some protection, but was uncertain how much or when during the year the treatments should be given for optimum protection. To find out, Sandquist and his colleague Thomas W. Koerber, research entomologist with the Pacific Southwest Station, carried out two consecutive experiments from 1985 to 1986. One compared the insect-battling potential of implants given in April to those given in May for cone-bearing Douglas-fir located in the North Fork John Day Ranger District of the Umatilla National Forest (near the Four Corners Campground). In the second study, conducted in the Unity District of the Wallowa-Whitman National Forest in the South and West Forks of the Burnt River drainage, treatments in late October and early November were compared to those given in April the following year.

Holes 3/8" wide are drilled every 4 inches around the entire circumference of the tree, so a capsule can be placed in each.

In the spring study, 60 trees were selected and randomly assigned to one of three treatment regimes. Twenty trees were treated with trunk implants on April 24, 1985, when cone buds were just beginning to enlarge but three weeks before the vegetative bud burst. Another 20 trees were treated on May 13, a week after the vegetative bud burst, with the rest left untreated.

For the spring/fall study, 45 trees in the Wallowa-Whitman National Forest were chosen with 15 being treated from October 28 to November 8, 1985, another 15 from March 25 to April 4, 1986 and the third set of 15 left untreated. The researchers measured surviving foliage density and insect populations for each group in the summer or early fall after treatment.

Their findings? The April treatment afforded greater protection than the May treatment both in terms of current year foliage and next year bud vegetation production, while the November treatment was equal in effectiveness to the April treatment in protecting trees from defoliation.

Koerber and Sandquist in fact found that 52 percent of branch tip samples taken from trees treated in April were completely free of defoliation and 75 percent had less than 25 percent defoliation. In contrast, only 3 percent of the shoots from the trees treated in May showed no defoliation damage, with 46 percent sustaining less than 25 percent defoliation.

Untreated trees suffered most damage, with 90 percent of their shoot samples completely defoliated. "The difference between the treated and untreated trees," said Koerber during an interview in his Berkeley office, "was obvious, even to the most casual observer."

Most important, the second study showed that the fall treatments were just as effective as the April treatments, with the majority of branches falling in the no defoliation class. This finding has significant economic and practical implications because it meant that implant treatments could be carried out at a time when conditions were more favorable.

"The early spring treatments worked well; but, unfortunately, that's a terrible time to get back into the woods," Koerber said. "The users aren't too happy about being waist deep in the snow. The solution was obvious," he said, "hit the trees in the fall."

Earlier studies suggested that it took approximately three weeks for the insecticide to reach maximum concentration in the foliage and even longer in the buds. Since mid-April is cone bud opening date and the time when the budworm larvae are their most populous, Koerber and Sandquist scheduled treatments for late March and early April.

Here a forester inserts an acephate capsule into the drilled hole.

Koerber explained that the habits of the budworm prompted the initial timing of the implants.

"They're geared right in with the cycling of the tree and seed production. When the buds open, the bugs are right there to feed."

But Koerber and Sandquist's studies proved that the fall treatments were just as effective as those given in early spring. No longer did treatments have to be conducted under the adverse conditions of early spring. All trees could easily be reached in fall using crews kept on from summer employment.

Untreated Douglas-fir on the left shows marked defoliation caused by the western spruce budworm while that on the right has been protected by pesticide implant treatments given the previous fall.

Program called cost efficient

In many cases, high-tech also means high-cost. But trunk implants are as cost efficient as they are effective. Ensuring that a valuable parent tree will have healthy scions and—barring frosts—viable seeds, means that reforestation programs can continue uninterrupted by the vagaries of pests and their appetites.

"It costs just as much to obtain poor material with a low probability of grafting success as it does to get good material," noted Koerber. "And, it's the same thing with the cones: collecting cones that are full of good seeds costs exactly the same as collecting cones that are full of worms."

The implants are also basically cheaper than conventional treatments. "One person armed with a cordless drill and a knapsack full of capsules can go out in almost any weather and reach trees that are not accessible by road or air," Koerber said.

And, when several trees in a single area are involved, an assemblyline approach can be adopted with one person boring the holes, another sticking the capsules into the tree, and a third driving them in with a ballpen hammer. Using this group method, Koerber said that one tree can be treated in under three minutes.

But the fiscal ramifications of unchecked pests extend beyond the immediate damage done to the trees or the costs of treatment.

"Reforestation programs have timetables. We select the trees one year and do the evaluations the next. But when cones have been eaten by insects or the trees have been defoliated and aren't producing any cones at all, it can suddenly be year five and we are only as far as we said we'd be at year two," said Koerber. False starts add incalculably to the cost of the program and may even jeopardize its success.

Side-effects?

One concern with trunk implants is whether they might, in the long run, adversely affect the health of the tree. What happens to a tree when it has as many as 20 holes drilled into it every year for several years? Is the insecticide harmful to the tree or do all these holes attract bark beetles? Is the physiology of the tree somehow impaired? These are some of the important questions that Koerber and his team are trying to find answers to.

One obvious threat would be girdling the tree. To avoid it, Koerber's current implant protocol calls for starting treatments a foot above ground level, then moving up a foot each year. "After five to seven years, you could, if necessary, start over again at the bottom, moving over two inches from the original site," Koerber said.

"In the areas where defoliation has been going on for several years, some people are putting their trees on an alternating schedule, treating them every other year," reported Vicky Erickson, area geneticist for the Umatilla and Wallowa-Whitman National Forests and on-site worker for the implant studies. She believes that this should prove a good compromise. Preliminary observations made by her and Sandquist suggest that there is enough residual pesticide protection during the untreated year to make this conservative approach reasonably effective.

Cooperation speeds deployment

"We didn't have to convince Sue Puddy (a silviculturist in the Wallowa-Whitman National Forest) that this was a good idea," mused Koerber. When he and Sandquist met Puddy in her Unity office to discuss the study's results, she had already prepared the paperwork requesting several thousand capsules (so many in fact, that Koerber had to make a quick call to the supplier to see if the order could be filled). "It's fairly impractical for us to be out early in the year, but Tom's work showed that applying the insecticide in the late fall when the trees have become dormant was just as effective as applying in early spring. Now, most of the districts are doing their applications in the fall."

Erickson estimated that, so far, she and Puddy have protected in excess of a thousand trees. "We are trying to move out and implant some of the adjacent trees that surround our principal trees to get their vigor up so that they can be producing pollen," Erickson said. The danger in protecting only one tree is that it might become predominantly self-pollinating, which would reduce the value of the seed stock.

Erickson believes that the decision to let potential users assist in the study was a wise one. "It was," she said, "a good example of how researchers and workers in the field are able to collaborate on a study that's very useful to both parties." Koerber and Sandquist's study may serve as a paradigm for scientific investigations which, like most in forestry, are likely to find immediate application should they prove to be effective and economical.

Two detailed reports provide more complete information on the experiments and are available from Pacific Southwest Station on request. These are *Effectiveness of Trunk-Implanted Acephate for Protection of Select Douglas-fir from Western Spruce Budworm Defoliation* (R6-86-15), and *Effectiveness of Fall and Spring Timings of Trunk-Implanted Acephate for Protection of Select Douglas-fir from Western Spruce Budworm Defoliation* (R6-87-01).

New from Research

A troubleshooting guide for wilderness recreation management

The Wilderness Act of 1964 established a system of areas to be managed in ways preserving both natural ecosystems and opportunities for wilderness experiences. Increased recreational use of these areas has made wilderness management a complex job. Managers now have more than 20 years of experience dealing with some general problems common to the entire wilderness system. And research into such problems and potential solutions to them has also been advancing.

It seems timely to synthesize wilderness management experience, condense it, and make it readily accessible to managers currently struggling with common problems. And that's what a new Intermountain Research Station report attempts to do. *Managing Wilderness Recreation Use: Common Problems and Potential Solutions* provides a "troubleshooting" guide to help wilderness managers select the most effective and efficient means of dealing with management problems. The guide shows managers faced with a specific problem—say, campsite deterioration—an array of approaches for dealing with the problem, along with the pros and cons of each approach.

The three-section guide is easy to use. The first section discusses strategies and tactics for dealing with problems. The second section describes common recreation-related problems in wilderness and their primary causes. The final and largest section discusses the pros and cons of the tactics identified in the report.

Although the report may not identify universal "best" solutions, because managers must always consider local conditions, it highlights the wide variety of potential solutions available and the advantages and disadvantages of each option. And this will help wilderness managers make better-informed decisions.

For a copy of the guide, request *Managing Wilderness Recreation Use: Common Problems and Potential Solutions*, General Technical Report INT-230.

How old's that aspen—a new way of finding out

Measuring aspen tree age from increment cores is an age-old method of estimating productivity and updating forest stand inventory. However, this traditional method of collecting cores in the field and then measuring them in the laboratory may soon be a thing of the past. Scientists at the Rocky Mountain Station have devised a new method that eliminates many of the problems associated with the old technique. Utilizing only a low-power microscope, core preparation is done directly in the field without chemical solutions.

The modified technique draws from earlier methods of shaving increment cores and later rewetting them in the lab. However, rewetting is ignored in this method and problems associated with core breakage, loss, desiccation, and deterioration due to fungal infection are eliminated.

Details about this new method are found in *Field Measurement of Age in Quaking Aspen in the Central Rocky Mountains*, Research Note RM-476. Copies are available from the Rocky Mountain Station.

Prescribed burning in sagebrush-grass rangelands

Use of prescribed burning for managing sagebrush-grass ranges has increased dramatically in recent years. But many resource managers who want to start or expand prescribed burning programs have only limited burning experience. Guidelines are certainly no substitute for experience, but a recent Intermountain Research Station report can help managers better plan and schedule fires, and increase their chances of success.

Guidelines for Prescribed Burning Sagebrush-Grass Rangelands in the Northern Great Basin outlines some procedures and considerations required when planning and conducting prescribed fires in sagebrush-grass ranges and monitoring the effects of these fires. The guidelines are primarily based on the authors' experience with this treatment in the northern Great Basin and Columbia River drainage. Because of variation, these guidelines should not be indiscriminantly applied to sagebrush-grass communities outside these areas, but many principles and considerations required to conduct prescribed fires apply throughout the sagebrush-grass region.

The report includes a summary of the literature on sagebrush-grass fire effects and a comprehensive bibliography of sagebrush-grass fire literature published since 1980.

Request a copy of *Guidelines for Prescribed Burning Sagebrush-Grass Rangeland in the Northern Great Basin*, General Technical Report INT-231.

User Fees— Pros and Cons

Would raising the user fees in the Nation's parklands increase the quality of recreation? A newly released report suggests a variety of pros and cons that deal with what some say is an undesirable necessity.

User fees are charged for National Park entrance, services and facilities, ski area operation, and guide, outfitting and other services. They also involve charges to concessionaries, leases for summer homes, and excise taxes on recreation equipment. Since their introduction in 1908 they have cushioned the cost of operating, administering, protecting and maintaining resources and facilities.

Fee proponents argue that increasing the fees would enable shrinking funds to be recovered and generate additional park revenues. Increases could also help rehabilitate areas that are lacking funds for simple maintenance purposes. And they could help redistribute use of areas and increase options for managers to make contact with the public. Opponents insist that it is unfair to charge recreationists twice—once through taxation and once with user fees. Other arguments stress that the fee-collection itself is degrading to the leisure experience that motivated use of an area in the first place.

Issues such as these are evaluated in the reprint titled *Recreation User Fees: I. Pros and Cons*. Historical aspects of fees, bills passed or opposed in Congress regarding them, the costs at various sites, and questions regarding the practical operation of user fee programs are also discussed. The Rocky Mountain Station has copies.

Aid for Thinning in Lodgepole Pine Stands

Determining thinning priorities among stands is a persistent problem in the management of lodgepole pine forests. Economic and biological influences must be considered, but thinning studies have not yet been conducted in a wide enough array of age, site, and density conditions to provide adequate thinning response equations. This limits computerized growth and yield simulations as thinning guides, until better data are available.

The Intermountain Research Station is taking a dual approach to the problem. A long-term program of empirical thinning studies will eventually provide data for reliable computer simulations of lodgepole pine stand growth and yield, to better determine stand priority for thinning. In the meantime, a recent study has developed a method for using the response of edge trees of existing clearings as an indicator of the relative thinning response potential of stands. The study is reported in a paper presenting a choice of edge-response models for field application, and providing instructions for calculating a Thinning Reponse Index for overstocked lodgepole pine.

The study report includes data requirements, sampling procedures, examples of model solutions and stand rankings, and suggestions for management applications.

For a copy of the report, request *Ranking Thinning Potential of Lodgepole Pine Stands*, General Technical Report INT-229.

Common shrubs of chaparral and related ecosystems

A key and illustrated guide to the *Common Shrubs of Chaparral and Associated Ecosystems of Southern California*, General Technical Report PSW-99, is now available from Pacific Southwest Research Station.

The publication, authored by Dr. C. Eugene Conrad, includes information on each species about its habitat distribution, response to fire, value as food for wildlife or livestock grazing, and its cultural value. The guide includes information on 132 of the most common and/or important shrubs in the southern California chaparral area.

Characteristics of lodgepole pine

Lodgepole pine has recently moved into prominence as an important wood and wood fiber species. The work on utilization of lodgepole pine is still in the early stages. An important contribution to this work is an Intermountain Research Station report documenting an indepth analysis of complete-tree specimens collected from the major ranges of lodgepole.

The study presents the complete characteristics of North American lodgepole pine as an industrial raw material. Information from the specimen analysis is reported in detail. The trees' locations are compared and correlated with their growth form, general characteristics, and even indepth analysis of moisture content of heartwood, sapwood, foliage, and wood and bark of roots, stem, and branches. Findings include how properties of lodgepole pines vary significantly with latitude, elevation, diameter class, and variety.

To obtain a copy of this report, request *Gross Characteristics of Lodgepole Pine Trees in North America*, General Technical Report INT-227.

Emergency ryegrass seeding to revegetate chaparral burns

The aftereffects of wildland fire in California have become an increasing problem as developments encroach on wildland areas. To alleviate postfire increases in erosion, public agencies often seed burned slopes with grasses (primarily *Lolium multiflorum*) to rapidly increase vegetative cover and protect the slopes from erosive agents such as wind and rain.

Questions about the effectiveness of this seeding in reducing erosion have increased in recent years. Many people have observed significant amounts of erosion occurring during and immediately after chaparral fires, before ryegrass has had a chance to establish. The effect of an introduced grass species on long-term species composition and richness is not known.

This literature review includes a history of seeding and current seeding practices, and examines the occurrence of accelerated erosion after fire, addresses meteorological and geographic constraints that influence establishment of seeded ryegrass and native plants, summarizes the information available on the influence of ryegrass on the chaparral system, and gives recommendations for future research.

Contact the Pacific Southwest Research Station for a copy of *Use of Ryegrass Seeding as an Emergency Revegetation Measure in Chaparral Ecosystems*, General Technical Report PSW-102.

Giving a hoot

Owls are quite representative of a trend being experienced by wildlife in general. Up to 20% of the world's 133 owl species are considered either endangered or seriously jeopardized by human activity. Who gives a hoot?—"Owlogists" from around the world who gathered February 3-7, 1987 in Winnipeg, Manitoba, Canada for technical presentations and workshops dealing with northern forest owl species and their pending fate.

This first-of-its-kind symposium featured 47 technical papers covering 15 owl species, and 4 workshops dealing with capture, telemetry, census, and management techniques.

The Symposium celebrated 100 years of wildlife conservation in Canada and drew from research in the Soviet Union, Germany, Finland, Norway, the United States and Canada. The symposium was designed to inspire greater public understanding and appreciation of the role owls play in the environment.

The 309-page report, titled *Biology and Conservation of Northern Forest Owls - Symposium Proceedings*, is available for $32.95 from the National Technical Information Service, 5285 Port Royal Rd., Springfield, Virginia 22161. Order publication #PB 88 119 995/AS. The report has also been distributed to libraries throughout the country.

Effects of ryegrass seeding on post-fire erosion and succession

Periodic wildfires in California chaparral alter ecosystems by removing vegetation from slopes and increasing erosion rates—especially during the first post-fire year. Increased erosion creates the potential for extensive offsite damages. In an attempt to minimize these damages, aerial seeding of ryegrass was adopted and has been used as a post-fire emergency revegetation measure for 40 years.

Very little information exists on effects of ryegrass seeding on erosion or natural succession in chaparral. In 1986, the PSW Riverside Fire Lab received funding from the California Department of Forestry and Fire Protection to investigate the effects of fire and post-fire rehabilitation measures on surface erosion and vegetation development in California chaparral.

Sites in four geographic areas have been selected—in the Santa Ana, Santa Monica, Santa Ynez and Santa Lucia Mountain Ranges—to assess regional variation on fire response and seeding establishment. Plots have been established, and pre-burn erosion and vegetation information is being collected. Sites are scheduled for prescribed burning (of moderate to high intensity) in the summer or fall of 1988. After burning, half of the experimental plots will be seeded, and compared with unseeded plots. Surface erosion will be measured using sheet metal troughs that collect debris moving downslope. Vegetation composition and response will be monitored at each site to assess fire and ryegrass seeding effects on native species succession.

Replicate sites will be burned within each geographic area over a three year period to account for variable weather patterns that may control post-fire erosion and vegetation response. Plots will be monitored for 3 to 10 years after the burns to quantify long-term effects of seeding on chaparral succession and site stability.

For more information, contact Sue Barro, Pacific Southwest Station, (714) 351-6523.

Idaho's Forest Resources

More than 40 percent of Idaho's land is forest. The State's forests are some of the most diverse in North America, if not the world. They range from lush green cedar and hemlock stands in the panhandle in northern Idaho, to the slow-growing trees of the pinyon-juniper type scattered throughout the southern portion of the State.

A recent forest survey revealed there are nearly 22 million acres of forest land in the State, and roughly 96 percent of these acres are classified as wood-product-yielding timberland. It is easy to see why the State has long been an important supplier of forest products.

The complete survey is reported in an Intermountain Research Station bulletin, and includes a description of Idaho's forest resources, their extent, condition, and location. Statistical tables in the report portray area by land classes, ownership, growing-stock and sawtimber volumes, growth, mortality, roundwood products output, utilization and residues. Two large, full-color maps are included with the report.

Idaho's Forest Resources, Resource Bulletin INT-39, is available from the Intermountain Research Station.

New seed zones for sugar pine

The first new seed zones for sugar pine to be developed in more than 20 years have been reported by geneticist Bob Campbell of the Pacific Northwest Station. Those previously available were derived from a map prepared by the Western Forest Tree Seed Council in 1966.

The new provisional seed zones and breeding zones are based on patterns of genetic variation in seedling progeny from 200 trees, growing in 142 locations in southern Oregon. Two zones are recommended for low elevations, two for middle elevations, and four for high elevations. Simulated transfers within a zone suggested that, in the average transfer, fewer than 25 percent of the seedlings are likely to be poorly adapted.

Variables measured to index the habitat of each tree were: elevation, aspect, slope, drainage direction, mean annual precipitation, horizon angle, and sun exposure on April 13.

Campbell cautions that the recommended zones are provisional, but says the delineation of zones does incorporate all available quantitative information about genetic and habitat variation of sugar pine in southwestern Oregon.

Details are provided in *Seed Zones and Breeding Zones for Sugar Pine in Southwestern Oregon*, Research Paper PNW-383, by Robert K. Campbell and Albert I. Sugano. Copies are available from the Pacific Northwest Station.

A gathering of wilderness research issues

The wilderness system is large and growing. In 1964, only 55 National Forests had any wilderness; now 128 do. More resource managers in more agencies have wilderness responsibilities than ever before, and almost surely more will in the future.

A strong knowledge base is essential to protect and manage the over 88 million acres of established wilderness, and much knowledge has been amassed since the early 1960's. But there remains a critical need for research-based knowledge, as wilderness management issues change and evolve. A symposium held in Ft. Collins, CO, in 1985 brought together many of the experts in wilderness research today.

The meeting included 35 perspectives on wilderness values, management, and research; states-of-knowledge for wilderness resource and wilderness user research; and future directions for wilderness research

For a copy of the symposium proceedings, request *Proceedings—National Wilderness Research Conference: Issues, State-of-Knowledge, Future Directions*, General Technical Report INT-220 from the Intermountain Research Station.

Using carbaryl to control MPB in lodgepole pine stands

The October issue of the Western Journal of Applied Forestry, Vol. 2, No. 4, includes an article by Dr. Patrick Shea of the Pacific Southwest Research Station, and Mark McGregor, of the Northern Rocky Mountain Region, USDA Forest Service. The article reports on their work on the Flathead National Forest in Montana, where they evaluated the effectiveness of various mixtures of carbaryl in protecting individual lodgepole pines from attack by mountain pine beetles.

For a copy of this reprint, contact the Pacific Southwest Station and request *A New Formulation and Reduced Rates of Carbaryl for Protecting Lodgepole Pine from Mountain Pine Beetle Attack.*

Biological control of insect pests

The work of entomologist Roger Ryan is the basis for two articles that appeared in the *Journal of Forestry* for July 1987. One article is an overview of the biological control of insect pests and its advantages; the other describes success in controlling the larch casebearer with natural enemies introduced from Europe and Japan.

Ryan is on the staff of the Pacific Northwest Station's Forestry and Range Sciences Laboratory in La Grande, Oregon. His research on the larch casebearer was the basis for a USDA Superior Service Award in 1986 and was the subject of stories in *Forestry Research West* for July 1978 and June 1986.

Biological control can be defined simply as the action of parasites, predators, or pathogens that keep a pest organism's population lower than it would be without the controlling organisms. Equilibrium in populations can easily be disturbed when the web of interactions that maintains that equilibrium is upset; for example, when pesticides are directed toward one pest but destroy innocuous organisms that play an important role in controlling other organisms.

One of the principal methods of biological control of pest insects inadvertently imported from abroad is to deliberately import their natural enemies. A summary compiled in 1974 shows that between 1889—when results were spectacularly demonstrated against the cottony cushion scale in California—and 1974, natural enemies were imported to help control 223 species of insect pests. Some control of more than half the pests, and complete control of 42 species was obtained.

Ryan lists some of the commonly given reasons that exotic natural enemies are not tried more often, and proceeds to nullify the reasoning. For example, one reason given is the lack of definitive proof of success in most projects. According to Ryan, proving that natural enemies are responsible for observed changes in pest density is seldom attempted. When the goal of controlling the pest is achieved, many people claim that the introduced enemy is responsible, many times correctly so, but do not prove it. Proof requires years of documenting declines in pest population coincident with increases in the imported enemy in different areas. Many people cannot commit the time or money to document the success.

The second article, written with Scott Tunnock and Frederick W. Ebel, describes the history of the larch casebearer in North America, including its successful biological control. The authors suggest guidelines that should be followed when any classical biological control project is evaluated.

For reprints, ask the Pacific Northwest Station for *Classical Biological Control: An Overview* by Roger B. Ryan, and *The Larch Casebearer in North America* by Roger B. Ryan, Scott Tunnock, and Frederick W. Ebel.

Chemistry of rime ice

Dieback and general decline of North American and European forest vegetation at high elevations has been documented. Although the causes of the decline are complex and not well understood, atmospheric deposition has been implicated as a stress-causing agent. These sites are often enshrouded in cloud cover, and the acidity of precipitates (such as rime ice) on vegetation is generally much higher than that of bulk precipitation.

Studies in Colorado suggest that rime deposits contribute about 10 percent to the water equivalent of the snowpack and up to 86 percent of the trace chemicals in the snowpack. There is almost no information on rime ice chemistry in California. The little information available suggests that rime deposits several tens of centimeters thick often accumulate on subalpine conifers.

Working at sites in the Sierra Nevada and Carson Range surrounding Lake Tahoe, Dr. Neil Berg and his team of scientists, of the Pacific Southwest Research Station, collected rime ice on special plastic screens. Their preliminary measurements indicate that concentrations of nitrate, calcium, potassium, sodium, magnesium, and hydrogen ions in rime collected on the plastic screens during the winter of 1986-1987 were typically 1.5 to over 4 times those of snow. The pH of snow from over 50 samples collected at three Lake Tahoe sites ranged from 5.1 to over 5.6. The pH of rime samples "paired" to the snow samples was always less than snow pH, and ranged from 4.25 to 5.5. Initial findings indicate that the ionic concentrations in rime were significantly greater than those in snow.

Intricately branched vegetation, either at its climatic elevation limit, or on locally exposed ridge crests, is especially susceptible to rime accumulation. The transition zone from trees to tundra or low-lying vegetation offers special aesthetic appeal and can receive high recreation impact. Many such areas are located in designated wilderness areas, which are to be administered unimpaired for future use. The potential for degradation of high-elevation vegetation, already stressed by extreme climates, needs to be better understood.

Dr. Berg and his team don't yet know how rime interacts with vegetation, so this winter they plan to sample rime on tree branches and compare the chemistry of these samples with samples collected on the plastic screens. Another question is how, or if, the rime interacts chemically with the vegetation, and whether the effect is an adverse one.

Dr. Neil H. Berg, Pacific Southwest Station, (415) 486-3456, can provide additional information.

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Effects of seeding mixes on post-fire establishment of native species

A new study recently undertaken in Southern California is evaluating the effect of various seeding mixes on the post-fire establishment of native chaparral species. The study is being conducted on an area burned in the Silverado Fire (Cleveland National Forest) in September 1987.

Ryegrass has commonly been used as a means of quickly revegetating slopes after fire in chaparral areas. But some claim it may help to eliminate native species through competition. The main objective of the study is to examine establishment of native shrub seedlings, native annuals and seeded annuals as well as the interactions between groups of species with respect to competition for space and nutrients.

The species being seeded onto plots are the following: Rygrass (*Lolium multiflorum*), Brome (*Bromus mollis*), Fescue (*Festuca megalura*), and a mix of six species of native annuals. The study plots will be monitored for 3 years.

For more information, contact Sue Barro or Jane Kertis at the Pacific Southwest Station, (714) 351-6523.

Journal reprint available on cattle/deer relationships

In the study reported in this reprint from the Journal of Wildlife Management, Vol. 51(3):655-664. hiding cover available for California and Rocky Mountain mule deer was monitored during summer under various cattle stocking rates. The study was carried out in quaking aspen and meadow-riparian habitats in the central Sierra Nevada, California. Using exclusion plots, scientists also measured the use of willow and herbaceous vegetation in meadow-riparian habitat.

Results indicated changes and resiliency of various types of hiding cover under the different levels of cattle stocking. For this reprint, contact the Pacific Southwest Research Station, and ask for *Influence of Cattle Stocking Rate on the Structural Profile of Deer Hiding Cover*.

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